

Mastering information security through standard implementation

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ABSTRACT

This paper aims to enhance information security within an organization, considering the perennial concern for security in organizations utilizing ICT applications. Educational institutions also exhibit deficiencies in the domain of data security. The adoption of international organization for standardization (ISO) 27001-2013 served to pinpoint potential vulnerabilities and non-compliance with safety standards, aiming to minimize associated risks. Through this framework, an assessment of data security within public educational institutions in our country was conducted, focusing on a public university as a case study. Given the sensitive nature of this field, guidance is provided on identifying security-related issues based on ISO 27001 standards and on-ground situations. Surveys were employed, aligning with the required standards, to scan the prevailing situation. Data from surveys at public academic institution were collected and analyzed using the SPSS application. The findings underscore instances where security protocols can prevent or mitigate abuses, consequently enhancing the overall level of data security. Emphasizing education as a pivotal recommendation, this study advocates for educating personnel who handle sensitive data, derived from the application of these standards. This paper accounts for potential risks that could expose organizational weaknesses and thoroughly elucidates the steps and procedures undertaken in this approach, substantiated by illustrated examples.

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1. INTRODUCTION

Due to the COVID-19 pandemic spanning from 2020 to 2022, our public academic institution was compelled to significantly intensify efforts in transitioning the entire educational process to a digital and online format. However, even prior to the pandemic outbreak, several university services were already being conducted digitally. These included student grading through the University Management System (SMU) platform, e-Learning with Moodle 3.2, utilization of the T-EDU platform, and access to various web services via the university's website [1]-[4].

Throughout the pandemic, these services gained paramount importance, catalyzing a shift from a semi-digital system to a fully digital one suitable for distance teaching. However, this transition presented various challenges, some of which could have been partly foreseen, given the unexpected circumstances by which many were caught unprepared. One of the most prominent challenges encountered during continuous digital communication was maintaining secure communication and data, both in transit and at rest [5]-[10]. These potential issues will be further explored and addressed in this research paper.

The findings in this study are based on observations conducted at our public institution. Despite the existence of numerous frameworks, we deliberately chose to focus on the international organization for standardization (ISO) framework, particularly ISO 27001:2013, within our research. ISO 27001:2013 serves as the core focus of this investigation, acting as a standard for auditing information system security and providing guidance for generating relevant documents such as findings and recommendations. It's important to note that ISO 27001:2013 encompasses 133 information security controls, allowing organizations to selectively adopt controls based on their specific requirements. The flexibility of ISO 27001 lies in its customization to meet the organization's needs, objectives, and security prerequisites, as well as its recognition as an information security management system (ISMS) both nationally and internationally [11]-[14]. Information security encompasses safeguarding the confidentiality, integrity, and availability of information [11]. Undoubtedly, risks persist, presenting threats to organizations in the pursuit of their operational and strategic objectives. The dynamic and multifaceted nature of the information security landscape further complicates the task of addressing these risks comprehensively. Information security standards provide extensive solutions for managing a diverse range of risks, with the aim of offering guidance to security managers in their efforts [15]-[17].

Guidelines for international information security management play a pivotal role in overseeing and certifying organizational information systems (IS). Standards and certifications delineate the prerequisites for sound information security management practices, encompassing information technology (IT) personnel, processes, systems, and policies. Among these standards, ISO/IEC 27001 holds substantial recognition, outlining the requirements for an ISMS, complemented by other standards within the ISO/IEC 27001 family [18]-[20].

Utilizing these standards empowers organizations of diverse natures to effectively oversee the security of critical assets such as financial information, intellectual property, and sensitive data entrusted by third parties. Globally, commercial and governmental entities adopt this standard as a cornerstone for policy management and information security implementation [5], [21], [22].

The increasing reliance of organizations on IT, coupled with the escalating impact of information security incidents, elevates information security as a primary concern for top management. An ISMS founded on ISO 27001 equates to risk management, synonymous with cost/benefit management. Companies are drawn to the risk-oriented approach facilitated by ISO 27001:2013 as these standards augment the security of their information assets [23]-[25].

ISO 27001:2013 encompasses fourteen (14) security controls, encompassing areas such as information security policies, organizational structure for information security, human resource security, asset management, access control, cryptography, physical and environmental security, operational security, communication security, system acquisition, development and maintenance, supplier relationships, information security incident management, aspects of business continuity management, and information security compliance [6], [16], [25]-[29].

2. RESEARCH QUESTIONS AND OBJECTIVES

This paper presents an approach for analyzing the communication security and the vulnerabilities of the digital transition of teaching institutions. The research questions and objectives have risen from practical concerns in a public educational institution case study, where the digital transition has been accelerated during the pandemic period. Therefore, the following research questions have been considered:

- How can data security in educational institutions be enhanced through the use of ISO 27001:2013 standard and through the informed identification of potential vulnerabilities?
- What are the key findings from the data analysis of the survey conducted at a case-study public academic institution using the SPSS application, and how can these results help address information security deficiencies at this institution?
- What recommendations can be provided to improve the level of data security in educational institutions, including the approach towards educating personnel responsible for sensitive data in accordance with the standards used in the ISO 27001:2013 study?

To address the identified research questions, the following objective were identified and considered throughout this work:

- Assessing the current state of information security: evaluate the existing data security protocols, practices, and compliance levels within public academic institution against ISO 27001:2013 standards.
- Identification of vulnerabilities and non-compliance in the case study: identification of potential weaknesses, vulnerabilities, and non-compliance areas within the data security framework of the educational institution, emphasizing gaps between existing practices and ISO 27001:2013 standards.

- Utilization of ISO 27001:2013 as a benchmark: Utilize ISO 27001:2013 standards as a benchmark to pinpoint deficiencies and potential risks within the information security infrastructure of our institution

3. RESULTS AND DISCUSSION

The public academic institution as an educational institution, faced the necessity to transition to an online format owing to the COVID-19 pandemic. This shift demanded a move from a relatively contained physical setting, in terms of experience, to an entirely digital online environment, significantly susceptible and insecure across all facets of data communication. Consequently, this situation necessitated a heightened awareness of digital security. Ensuring the security of information and minimizing its misuse stands as a critical mission for the public university. In this new paradigm, preserving the study culture and teaching quality for numerous professors becomes imperative, while concurrently establishing stronger governance and enhanced security oversight within academic operations and programs. Successfully meeting this challenge entails adherence to existing safety standards. Our strategy for achieving the public university data security management has followed the established path, integrating best practices outlined in ISO 27001:2013 across all organizational levels in testing processes and operations. The standardized directives of ISO 27001 encompass not only IT protocols and functionalities but also considers all stakeholders involved to prevent any potential data leakage or misuse. The university's data system is predominantly accessed by ITC staff, managerial personnel, professors, students, among others. Evaluating the perception of security levels within the data system was conducted through a survey mechanism involving groups actively engaging with digital systems across the university. This endeavor has significantly impacted the educational aspect related to data security within our systems. Given the necessity to gather information from diverse sources and departments, an action plan was devised encompassing all the stages outlined in this paper. Consequently, this paper is structured around four distinct phases in its entirety, which are described in the following sub-sections.

3.1. Stage 1 - Data collection planning and questionnaire preparation

An ISO 27001:2013 checklist was developed to serve as a framework for an information collection model. Questionnaires were designed aligning with this checklist of standards and distributed to relevant departments primarily responsible for ITC within the organization. Tailored questionnaires were specifically crafted for key member groups within the system, such as ITC staff, professors, and administrative personnel, following the guidelines outlined in ISO 27001:2013 standards. This approach facilitated a more precise gathering of data and a deeper comprehension of the current situation. Additionally, it aided in formulating a more accurate action plan aimed at addressing tangible issues effectively.

3.2. Stage 2 - Data collection

During this phase, surveys created via google forms were disseminated to various groups. These questionnaires were tailored considering the inherent responsibilities shared within the respective domains. Surveys were grouped based on the following classifications:

- IT and administrative personnel
- Academic personnel
- Students

3.3. Stage 3 - Analysis, filtering, and grouping

The collected data underwent comprehensive analysis and filtering, establishing connections with existing functional actions. A meticulous examination was conducted using responses gathered from participant groups within the system. Several findings from these analyses are visually represented through Figures 1 to 3 provided below. This analytical process also paved the way for the subsequent phase, enabling the proposal of corrective actions aligned with prioritized areas and potential risk assessments.

3.4. Stage 4 - Corrective actions and proposals

This phase highlights comprehensive details encapsulating all findings regarding the information security situation. It incorporates immediate and subsequent corrective actions aimed at averting, preventing, or mitigating any potential adverse events. The categorization of questionnaires for IS security within an organization for this particular case follows the standard delineations in ISO 27001, such as 5.1.1, 6.1.1, 8.1.1, 9.1.1, 9.2.1, 11.1.1, 12.1.1, 11.2.1, 13.1.1. The respondents in this study comprised three groups of digital information users within the university: IT department, administration, faculty, and students. The responses sought to address the pertinent aspects of ISO 27001 points. Following are the survey results obtained for three specific points (11.2.1, 9.4.3, and 6.1.1). In Table 1, can be seen the processed data and

results through the SPSS application for point 12.2.1 of the ISO 27001:2013 standard. In Table 2, can be seen the processed data and results through the SPSS application for point 9.4.3 of the ISO 27001:2013 standard. In Table 3, can be seen the processed data and results through the SPSS application for point 6.1.1 of the ISO 27001:2013 standard. Point 11.2.1 of the ISO 27001 standard addresses: “Are there defined policies for equipment deployment and protection?”

Table 1. Result for point 11.2.1 from ISO 27001

11.2.1 Are there defined policies for equipment deployment and protection		Frequency	Percent	Valid percent	Cumulative percent
Valid	YES	5	26.3	27.8	27.8
	NO	1	5.3	5.6	33.3
	I have no information	12	63.2	66.7	100.0
	Total	18	94.7	100.0	
Missing	System	1	5.3		
Total		19	100.0		

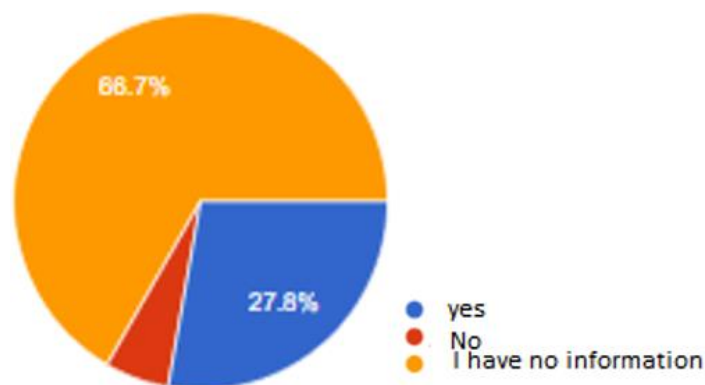


Figure 1. Graphic for point 11.2.1 from ISO 27001, Source: Authors' computation, 2023

Point 9.4.3 of OSI 27001 standard is: “Are there defined policies for managing passwords securely?”

Table 2. Result point 9.4.3 from ISO 27001

9.43 Are there policies definded for security password management		Frequency	Percent	Valid percent	Cumulative percent
Valid	YES	9	47.4	47.4	47.4
	NO	2	10.5	10.5	57.9
	I have no information	8	42.1	42.1	100.0
	Total	19	100.0	100.0	

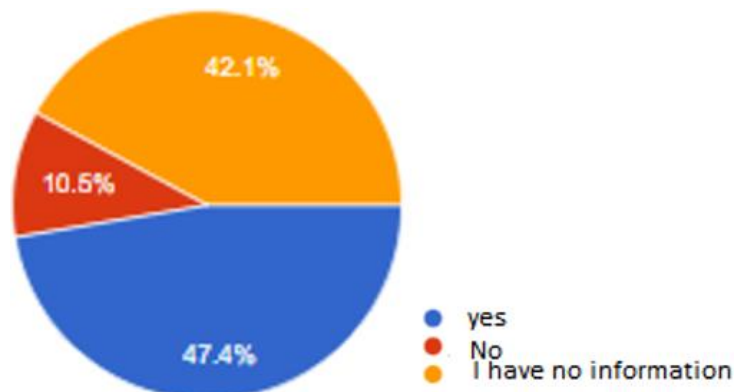


Figure 2. Results for point 9.4.3 from ISO 27001, Source: Authors' computation, 2023

Point 6.1.1 of the OSI 27001 standard is: “Are roles and responsibilities defined in IT within the organization?”

Table 3. Result for point 6.1.1 from ISO 27001

9.43 Are IT roles and responsibilities defined?		Frequency	Percent	Valid percent	Cumulative percent
Valid	YES	15	78.9	78.9	78.9
	NO	3	15.8	15.8	94.7
	I have no information	1	5.3	5.3	100.0
	Total	19	100.0	100.0	

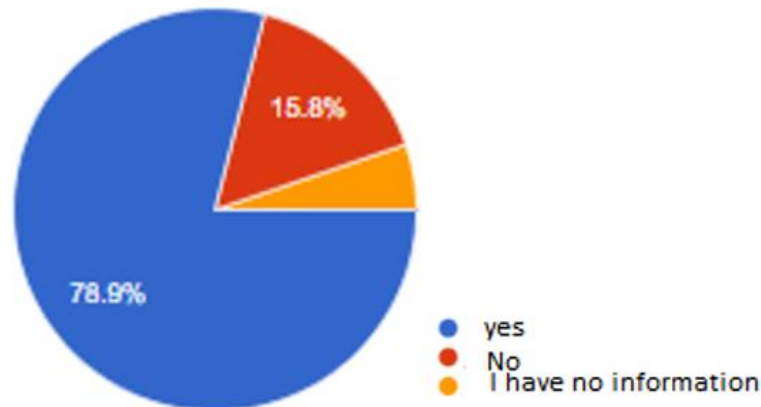


Figure 3. Results for point 6.1.1 from ISO 27001, Source: Authors' computation, 2023

The survey was categorized as follows:

- Fully applicable or met
- Not applicable
- Insufficient information

Three potential outcomes are anticipated from the objectives of this research, each accompanied by its corresponding level of risk:

1. High opportunity-high risk
2. Moderate opportunity-medium risk
3. Low opportunity-low risk

The classification based on the above criteria was established by predefining the factual circumstances and assumptions associated with each of these categories were considered.

The following classification of rules were formulated in alignment with the previously established division:

1. High probability: There is a high possibility of occurrence, as evidenced by recorded instances in the past within this or similar institutions.
2. Moderate probability: It could transpire if a specific triggering event occurs and necessitates an experienced perpetrator.
3. Low probability: It is unlikely to occur, although feasible, but demands a highly skilled and prepared perpetrator.

In terms of risk categorization, the following criteria were utilized:

1. High risk: If this event occurs, it will be exceedingly challenging to contain and may lead to other adverse occurrences. This category also encompasses risks that can impede and disrupt operations.
2. Moderate risk: Represents a risk that could cause significant complications and disturbances, potentially disrupting operations for a brief period, but may be reversible.
3. Low risk or no risk: These are events that may occur but will not disturb or prevent operations. These events are localized to specific segments of an organization and can be easily managed.

In Table 4, a matrix comprising rows and columns has been established, with the three options arranged vertically and three levels of risk positioned horizontally, in compliance with qualification rules.

Table 4. Risk evaluation

Risk occurrence	Low risk	Medium (moderate) risk	High risk
Low probability	6.1.1		
Medium (moderate) probability	9.4.3		
High probability			11.2.1 9.1.2

Source: Authors' computation, 2023

In the specific scenario, detailed information regarding point 9.1.2 was thoroughly examined. This point refers to “Policy set for access to networks and network services?” The evaluation included assessing the extent of access to a local network, determining whether it is unregulated or easily accessible from outside the University Campus. Additionally, consideration was given to past occurrences of potential attacks targeting the following points:

- Has there been a known MITM (man in the middle) attack to steal and collect sensitive data at the University? The answer was YES.
- Has anyone ever tried to access data and try to gather information? The answer was YES.

This finding for point 9.1.2 is placed in the high probability category together (along) with point 11.2.1. Alternatively, in the event that non-compliance with 9.1.2 leads to an incident, it becomes essential to assess the potential level of damage that could ensue. The following crucial questions aim to solicit diverse responses and shed light on pertinent aspects:

- If someone manages to access and collect information from the database management or administrator, can they delete the database? The answer is Yes.
- If someone accesses the network, can they interrupt the processes and/or refuse the service? The answer is yes.
- If someone can access the University LAN, can they install some kind of malware, ransomware, virus or trojan, which will disturb the process for a longer time, with the possibility of permanent, partial data loss or complete? The answer is Yes.

Thus, based on the survey results utilized through google forms for point 9.1.2, the degree of risk for this specific point will be further analyzed as a future action. Additionally, another step of this work requires dealing with the corrective actions, necessary to achieve the required level of security. Moreover, an additional aspect of the paper focuses on implementing necessary corrective measures to reach the stipulated level of security. This mapping of actions provides a clear overview of the scope each action should cover.

Upon completion of the corrective actions map, all required actions will be colored in three distinct colors: green, orange and red. The color scheme will be derived from previous spreadsheets representing real-world field situations.

A detailed description of each action suggested by the correction matrix was compiled. If the action to be taken is technical or something to be addressed from an engineering or technical point of view, a detailed description of what needs to be done will be devised in coordination with local IT management. However, should there be a need for administrative or legal measures, supplementary regulations will need to be drafted and approved to align with the university's requirements, following the standards derived from ISO 27001:2013 and in accordance with existing legislations.

4. CONCLUSION




The security of data, both in transit and at rest within digital systems, continues to pose a persistent challenge, with complete assurance of security remaining elusive even today. Addressing this challenge for the future requires implementing standards aimed at fostering safer digital environments. Among the most prominent frameworks is ISO 27001-2013, which delineates rules aimed at elevating security levels. This adaptable framework finds relevance in educational institutions such as our university offering a structured approach to fortify security measures. The data collection for this paper underwent several stages: foreseen points outlined in the ISO 27001:2013 standard, formulation of questionnaires tailored for three user categories, and the utilization of google forms to gather responses from questionnaires. Subsequent analysis of these results facilitated the determination of security levels corresponding to pertinent points within the ISO security framework. Drawing from these field-acquired data, recommendations were provided to address areas where the security level fell short of expectations, information security was not at the desired level. Additionally, a risk evaluation table was computed, positioning points based on their real-world scenarios. Emphasizing the crucial role of education in cultivating a more secure information system management, an essential finding emerged regarding the educational influence on data users regarding information security

within an organization. This underscores the fundamental role of education in cultivating a more robust and secure information system.




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